THE CHEMISTRY OF COOKING AND CLEANING

By

ELLEN H. RICHARDS

A 000 503 901 1
UC SOUTHERN REGIONAL LIBRARY FACILITY

California
egional
acility

THE LIBRARY
OF
THE UNIVERSITY
OF CALIFORNIA
LOS ANGELES

1543
1543

STATE NORMAL SCHOOL,
Los Angeles, Cal.

UNIVERSITY of CALIFORNIA
AT
LOS ANGELES
LIBRARY

Digitized by the Internet Archive
in 2007 with funding from
Microsoft Corporation

http://www.archive.org/details/chemistrycooking00richiala

STATE NORMAL SCHOOL,
Los Angeles, Cal.

THE CHEMISTRY

OF

COOKING AND CLEANING

1543

A MANUAL FOR HOUSEKEEPERS

BY

ELLEN H. RICHARDS

INSTRUCTOR IN CHEMISTRY, WOMAN'S LABORATORY,
MASSACHUSETTS INSTITUTE OF TECHNOLOGY,
BOSTON

BOSTON
ESTES & LAURIAT
301 — 305 WASHINGTON ST
1882

1543

Copyright, 1881.
BY ESTES & LAURIAT.

UNIV. OF CALIFORNIA
LOS ANGELES LIBRARY

TX
531
R39c

PREFACE.

—:o:—

IN this age of applied science, every opportunity of benefiting the household should be seized upon.

The family is the heart of the country's life, and every philanthropist or social scientist must begin at that point. Whatever, then, will enlighten the mind, and lighten the burden of care, of every housekeeper will be a boon.

At the present time, when the electric light and the gas stove are familiar topics, there is, after all, no branch of science which might be of more benefit to the community, if it were properly understood, than Chemistry — the Chemistry of Common Life. Johnston's excellent book with that title deserves a wider circulation, and a more careful study.

But there is a space yet unoccupied for an elementary work which shall give to non-scientific readers some practical information as to the chemical composition of articles of daily use, and as to their action in the various operations in which they are employed.

The public are the more ready for the application of this knowledge since Chemistry is taught in nearly all High Schools, and every child has a dim idea of what some part of it means. To gather up into a definite and practical form these indistinct notions is the aim of this little book.

There is, lingering in the air, a great awe of chemistry and chemical terms, an inheritance from the age of alchemy. Every chemist can recall instances by the score in which manufacturers have asked for recipes for making some substitute for a well-known article, and have expected the most absurd results to follow the simple mixing of two substances. Chemicals are supposed by the multitude to be all-powerful, and great advantage is taken of this credulity by unscrupulous manufacturers.

The number of patent compounds thrown upon the market under fanciful and taking names is a witness

to the apathy of housekeepers. It is time that they should bestir themselves for their own protection. A little knowledge of the right kind cannot hurt them, and it will surely bring a large return in comfort and economy.

These mysterious chemicals are not so many or so complicated in structure but that a little patient study will enable any one to understand the laws of their action, as far as they are concerned in the common operations of the household.

No attempt is here made to cover the whole ground of chemical science, but only to explain such of its principles as are involved in the raising of bread, and in a few other common processes.

CONTENTS.

Chap.		Page.
I.	Introduction,	1
II.	Starch, Sugar, and Fat, as Food.	16
III.	Nitrogenous Food and the Chemistry of Nutrition.	37

PART II.

I.	The Chemistry of Cleaning,	55
II.	Chemicals for Household Use,	80

CHAPTER I.

INTRODUCTION.

WE recognize substances, as we know people, by their characters (properties) and by their appearance. Sugar we call sweet; if anything is sour, we call it acid. Sugar and salt dissolve in water. Carbonic acid gas will extinguish the flame of a candle. These are properties of the several substances. A teaspoonful of sugar heated over a fire turns black, swells up to a large bulk, emits a gas which burns with a smoky flame, and finally there is left a black, crumbly mass, which seems like what it is, fine charcoal. There is nothing which we consider sugar left, no sweetness, none of the properties which we know under the name of sugar. There

is a change, a loss of identity. This change is called a chemical one.

Add a solution of an acid to a solution of an alkali, and observe that the acid substance and the alkaline substance are no longer in existence as such. There is, instead, a neutral saline substance dissolved in water. The new substance has not the properties of either of the others. The acid and the alkali have both lost their identity. A chemical change, then, involves a loss of identity.

"We must be very careful not to transfer our ideas of composition, drawn chiefly from the mixtures we use in common life, directly to chemistry. In these mixtures the product partakes, to a greater or less degree, of the character of its constituents, which can be recognized, essentially unchanged, in the new material. In all instances of true chemical union and decomposition, the qualities of the substances concerned in the process entirely disappear, and wholly different substances with new qualities appear in their place."*

* "The New Chemistry."—Josiah P. Cooke. *p.* 99.

All the substances about which we know anything are composed of a few elementary bodies. The grain of wheat, the flesh of animals, the dangerous poison, all are capable of being separated into the simple substances of which they are composed. The chemical element is that substance out of which nothing essentially different* has ever yet been obtained. Pure gold is an element, a simple substance, from which nothing can be taken different from itself. A gold coin contains a little copper or silver, or both, and is not pure gold; it is a mixture of two or more elementary substances. The oxygen in the air is an element, a single thing. Water is a compound of two elements, oxygen and hydrogen, which are gases when they exist as simple substances.

There are about seventy of these elementary substances known to the chemist; about ten or twelve of them enter into the compounds which we use in the kitchen. The others are found only in the chemical laboratory or in the physician's medicine case, and a few are so rare as to be

* "Treatise on Chemistry."—Roscoe & Schorlemmer. *p.* 51.

considered curiosities. Most of these elements unite with each other, and, in the compounds thus formed, other elements may exchange places with those already there, so that a few elementary bodies, by the variety of combination, make up the objects of daily use.

To understand something of the nature of these chemical substances and their common forms is a necessity for every housekeeper who would not be cheated of her money and her time.

It is important for every one to remember that laws govern all chemical changes; for one is often asked to believe that some chemical sleight of hand can make one pound of washing-soda worth as much as two, and that some special preparation of flour will give a third more bread than any other.

As has been said, we recognize substances by their properties, and the chemical elements have two essential characteristics which must be considered at the outset of our discussion.

It is assumed that they are composed of homogeneous particles, the so-called atoms, the smallest

masses of matter which enter into chemical combination. The particles have a definite weight, constant for each substance. This weight is known in chemistry as the atomic weight.

Hydrogen being the lightest substance yet known, its atomic weight is taken as the unit.

TABLE I.

NAME.	SYMBOL.	ATOMIC WEIGHT.
Hydrogen	H	1
Sodium (Natrium)	Na	23
Calcium	Ca	40
Oxygen	O	16
Carbon	C	12

The atom of oxygen weighs 16, and the atom of calcium 40 times as much as the atom of hydrogen. The letters or symbols in chemical formulæ represent this definite weight, so that while the word *oxygen* means only that collection of properties to which we give the name, the letter O in a formula indicates also 16 times the weight of H, which is taken as 1.

These symbols give a definiteness to the chemical

terms which words merely cannot convey, and therefore they are a great aid to the right comprehension of the laws of combination. In a table at the end of the book will be found the atomic weight of all the elements referred to in the text.

The atoms of each element have also their own value in uniting and exchanging places with the others.

The unit of value is an arbitrary standard. Something else might have been taken than the unit chosen, but the relative value of all the elements as compared with each other is constant.

At the outposts of the Hudson's Bay Territory all trade is on a system of barter or exchange, and a basis of value is necessary. The skin of a beaver is agreed upon as the unit from which to count all values. For example: a red fox skin is worth two beaver skins, a silver fox skin is worth four beaver skins. All of the hunter's stock is valued in this way, and also articles to be purchased are valued by the same standard, a knife is purchased for four beaver skins, a gun is worth three silver fox or twelve beaver skins. Chemists have

agreed upon a unit of value in exchange, and the unit thus agreed upon is the atomic weight of hydrogen above referred to; that is, the smallest relative weight of hydrogen known to enter into combination with other elements. It is, in a sense, an arbitrary choice, but having once accepted it as the unit, we can count all other values, in union or in exchange, from its value.

TABLE II.

NAME.	SYMBOL.	NUMBER OF ATOMS OF HYDROGEN WHICH THE ATOM OF THE SUBSTANCE WILL REPLACE IN COMPOUNDS.
Sodium (Natrium)	Na	1
Calcium	Ca	2
Oxygen	O	2
Carbon	C	4

For the convenience of the reader, this exchangeable value will be indicated by the numbers over the letters in the formulæ given in this book, although the practice is not universal.

The chemist has constructed a sign language, based upon these two properties of the elements, which aids the mind in grasping the idea of

chemical changes. The symbols are, as it were, the chemist's alphabet.

The non-scientific reader is apt to look upon the acquisition of this sign language as the school-boy regards the study of Chinese — as the work of a lifetime. While this view might not be so very far from the truth, if one were to attempt to remember all the symbols of the complicated compounds which are possible in the union and interchange of the seventy or more elements, yet the properties and combinations of the dozen of them which make up the common substances of daily use are not beyond the reach of the busy housewife, and can be comprehended in a few hours of thoughtful reading. "To master the symbolical language of chemistry, so as to fully understand what it expresses, is a great step towards mastering the science." *

Hydrogen seems to be the connecting link between the other elements, which may, for our present purpose, be divided into two classes, as shown in

* "The New Chemistry." *p.* 149.

TABLE III.

CLASS I. Some elements which can be substituted for H, and for each other in chemical compounds.	EXCHANGE VALUE.	CLASS II. Some elements which unite with H, and with Class I., as well as with each other.	EXCHANGE VALUE.
Sodium	$\overset{I}{Na}$ 1	Chlorine	$\overset{I}{Cl}$ 1
Potassium	K 1	Oxygen	$\overset{II}{O}$ 2
Calcium	$\overset{II}{Ca}$ 2	Carbon	$\overset{IV}{C}$ 4
	Hydrogen	$\overset{I}{H}$ 1	

$\overset{I}{H}$ unites with $\overset{I}{Cl}$, and forms $\overset{I\ I}{HCl}$, or muriatic acid. $\overset{I}{K}$ exchanges places with $\overset{I}{H}$, and the new compound is $\overset{I\ I}{KCl}$. $\overset{I}{H_2}$ unites with $\overset{II}{O}$, and forms $\overset{I\ II}{H_2O}$, or water. $\overset{I}{K_2}$ exchanges places with $\overset{I}{H_2}$, and the new compound is $\overset{I\ II}{K_2O}$. $\overset{IV}{C}$ unites with $\overset{II}{O_2}$ and forms $\overset{IV\ II}{CO_2}$, carbon dioxide, or carbonic acid gas. $\overset{IV\ II}{CO_2}$ unites with $\overset{I\ II}{H_2O}$, and becomes $\overset{I\ IV\ II}{H_2CO_3}$, or carbonic acid in solution. $\overset{I}{Na_2}$ exchanges places with $\overset{I}{H_2}$, and the new compound

is $\overset{I}{Na_2}\overset{IV}{C}\overset{II}{O_3}$, or commercial soda ash, the compound with which the laundress is familiar, under the name of washing crystal.

The letters mean always the smallest relative quantity known to combine with anything else, and when the elements combine in more than one proportion, we indicate it by writing two times or three times the units. Thus $\overset{I}{H_2}$ or $2\overset{I}{H}$ means twice the unit value of $\overset{I}{H}$.

Some of the compounds formed by the union of the elements given in the Tables are very familiar substances.

$\overset{I}{H_2}\overset{II}{O}$	Water.
1 x 2, 16	Two parts by weight of hydrogen.
	Sixteen parts by weight of oxygen.
	1 O will unite with 2 H.
$\overset{II}{Ca}\ \overset{II}{O}$	Quick-lime.
40, 16	Forty parts by weight of calcium.
	Sixteen parts by weight of oxygen.
	1 Ca will exchange places with 2 H.
$\overset{IV}{C}\overset{II}{O_2}$	Carbonic acid gas.
12, 16 x 2	Twelve parts by weight of carbon.
	Thirty-two parts by weight of oxygen.

The exchanges and interchanges of the elements according to these two laws of value and weight are chemical reactions, and the expression of them is called a chemical equation. A certain modicum of chemical arithmetic is essential to the right understanding of these reactions.

"In the laboratory we never mix our materials at random, but always weigh out the exact proportions . . . for, if the least excess of one or the other substance over the proportions indicated is taken, that excess will be wasted. It will not enter into the chemical change." *

In the economy of nature nothing is lost. The wood and coal burned in our stoves do not vanish into thin air, without adding to its weight. Twelve lbs. of coal (not counting the ash), in burning, take 32 lbs. of oxygen, and there are formed 44 lbs. of carbonic acid gas.

In all chemical equations there is just as much in weight represented on the one side of the sign of equality (=) as on the other.

* "The New Chemistry." p. 151.

For instance, in the equation

$$\overset{\text{I I}}{\text{HCl}} + \overset{\text{I I II}}{\text{NaHO}} = \overset{\text{I I}}{\text{NaCl}} + \overset{\text{I II}}{\text{H}_2\text{O}}$$

Muriatic Acid.	Caustic Soda.	Sodium Chloride or Salt.	Water.

$$36.5 + 40 = 58.5 + 18$$

$$76.5 = 76.5$$

The sum of the weights of the two substances taken is equal to the sum of the weights of the two new substances formed as the result of the reaction.

The present science of chemistry may be said to date from the discovery of the law of definite proportions, which gave a firm basis for all calculations. If we wish to obtain 44 lbs. of carbonic acid gas (carbon dioxide), we can tell just how much pure charcoal must be taken, by writing out the reaction thus:

$$\overset{\text{IV}}{\text{C}} + \overset{\text{I}}{\text{O}_2} = \overset{\text{IV II}}{\text{CO}_2}$$

The atomic weight of Carbon is 12, $\times$ 1 = 12
The atomic weight of Oxygen is 16, $\times$ 2 = 32

44

Therefore 12 lbs. of charcoal must be burned in order to obtain 44 lbs. of carbonic acid gas.

This law of definite proportion by weight cannot be too strongly emphasized. It is the invariable rule of chemical action, and it will be referred to again and again in discussing the chemical changes occurring in cooking and in digestion.

When more than two elements enter into combination, it is common for two or more to band together, and in this case the group has an exchange value of its own, which is not the sum of the values of the separate elements, but which is constant, and dependent upon these values in a way which it is not necessary to explain here.

These partnerships will be included in brackets as $\overset{II}{(SO_4)}$ $\overset{II}{(CO_3)}$ $\overset{I}{(NO_3)}$, not that these letters represent actual compounds existing by themselves, as do $\overset{I\ II}{H_2O}$, $\overset{IV\ II}{CO_2}$, $\overset{II\ I}{CaCl_2}$, but that the group enclosed in the brackets passes from one compound into another as if it were only one element, and the numbers over the bracketed letters will indicate the exchange value of the partnership, not of the elements separately. A few illustrations will serve to make this clearer.

TABLE IV.

Mineral Acids and Compounds:

$\overset{I\ I}{HCl}$	$\overset{I\ \ I}{H(NO_3)}$	$\overset{I\ \ II}{H_2(SO_4)}$	$\overset{I\ \ II}{H_2(CO_3)}$
Muriatic.	Nitric.	Sulphuric.	Carbonic.
$\overset{I\ I}{NaCl}$	$\overset{I\ \ I}{K(NO_3)}$	$\overset{II\ \ II}{Ca(SO_4)}$	$\overset{II\ \ II}{Ca(CO_3)}$
Salt.	Saltpetre.	Plaster of Paris.	Marble.

Reactions and Equations:

$$\overset{I\ \ II}{H_2(SO_4)} + \overset{II\ \ II}{Ca(CO_3)} = \overset{II\ \ II}{Ca(SO_4)} + \overset{I\ \ II}{H_2(CO_3)}$$

$$\overset{I\ \ II}{H_2(SO_4)} + 2\overset{I\ I}{(NaCl)} = \overset{I\ \ II}{Na_2(SO_4)} + 2\overset{I\ I}{(HCl)}$$

$$\overset{I\ \ II}{H_2(SO_4)} + \overset{I\ I}{NaCl} = \overset{I\ I\ \ II}{NaH(SO_4)} + \overset{I\ I}{HCl}$$

It will be seen that the groups do not separate, but that they combine with the single elements by the same law as that which governs the combinations of the simple substances.

It is also to be observed that where two atoms of hydrogen can be replaced in a compound, as in $\overset{I\ \ II}{H_2(SO_4)}$, either one or both can be exchanged for an atom of equal replacing value, and the two compounds thus formed will differ in their properties. This will be shown later on, in the case of cream of tartar.

For a full and clear exposition of the principles of the science, the reader is referred to "The New Chemistry," by J. P. Cooke.

CHAPTER II.

STARCH, SUGAR, AND FAT, AS FOOD.

WHEREVER there is life, there is chemical change, and as a rule a certain degree of heat is necessary, in order that chemical change may occur. Vegetation does not begin in the colder climates until the air becomes warmed by the heat of spring. When the cold blasts of winter come upon the land, vegetation ceases. If plant life is to be sustained during a northern winter, artificial warmth must be supplied. This is done by keeping up a furnace or stove heat. In chemical terms, carbon from coal, wood, or gas is caused to unite with the oxygen of the air to form carbonic acid gas, and by this union of two elements, heat is produced:

$$\overset{IV}{C} + \overset{II}{O_2} = \overset{IV\ II}{C\,O_2}.$$

In wood and gas there is another compound which is utilized:

$$\overset{IV\ I}{C\,H_4} + \overset{II}{O_4} = \overset{IV\ II}{C\,O_2} + 2\ \overset{I\ II}{H_2O}.$$

These two chemical reactions express the changes which cause the production of artificial heat used for domestic purposes.

As many animals live in temperatures in which plants would die, it is evident that they must have some source of heat in themselves. This is found in the union of the oxygen of the air breathed, with the carbonaceous matter eaten as food, and the formation of carbonic acid and water ($\overset{IV\ II}{C\,O_2}$ and $\overset{I\ II}{H_2O}$), just as in the case of the combustion of the wood in the grate. Only, instead of this union taking place in one spot, and so rapidly as to be accompanied by light, as in the case of the grate fire, it takes place in each drop of the fluid circulating in the body, and so slowly and continuously as not to be noticed. Nevertheless the chemical reaction seems to be identical.

The first condition of animal life to be studied is, then, that portion of the food which supplies the heat necessary for the other chemical changes to take place. The class of foods which will be here considered as those for the production of animal heat, includes carbon compounds, chiefly composed of carbon, hydrogen, and oxygen.

These carbonaceous bodies need abundance of oxygen for their slow combustion or oxidation, and hence the diet of the animal must include fresh air,—a point too often overlooked. It does not make a bright fire to pile on the coal without opening the draught.

A certain quantity of heat is produced by other causes than this combustion of carbon compounds, which will be considered later, but the best authorities seem to now agree that the chief heat-producing foods used by the human race include starch, sugar, and fat.

Starch is the first in importance, both from its wide distribution and its extensive use. Starch is found in all plants in greater or less abundance. It is laid up in large quantities in the seeds of

many species. Rice is nearly pure starch, wheat and the other cereals contain sixty to seventy per cent of it. Some tubers contain it, as potatoes, although in less quantity, ten to twenty per cent. It is formed from the carbonic acid gas and water contained in the air, by means of the living plant-cell and the sun's rays, and it is the end of the plant life, the stored energy of the summer, prepared for the early life of the young plant another year.

Common sugar, cane-sugar, is found in fruits and the juices of some plants. It is directly or indirectly a product of plant life. The chemical transformations of starch and sugar have been very carefully and scientifically studied, with reference to brewing and wine-making.

Several of the operations concerned necessitate great precision in respect to temperature and length of time, and these operations bear a close analogy to the process of bread-making by means of yeast. The general principles on which the conversion of starch into sugar, and sugar into alcohol, are conducted, will therefore be stated as

preliminary to a discussion of starch and sugar as food.

There are two distinct means known to the chemist, by which this change can be produced. One is by the use of acid and heat, which changes the starch into sugar, but can go no farther. The other is by the use of a class of substances called ferments, some of which have the power of changing the starch into sugar, and others of changing the sugar into alcohol and carbonic acid gas. These substances are in great variety, and the germs of some of them are always present in the air.

A substance is formed in sprouting grain which is called diastase, or starch converter, which first changes the starch into sugar or glucose, under the influence of warmth, as is seen in the preparation of malt for brewing. The principal chemical change is expressed by the following re-action:

$$\underset{\text{Starch.}}{\overset{IV\ I\ II}{C_6H_{10}O_5}} + \underset{\text{Water.}}{\overset{I\ II}{H_2O}} + \text{ferment} = \underset{\text{Sugar (glucose).}}{\overset{IV\ I\ II}{C_6H_{12}O_6}}$$

The sugar formed from starch is one of the

class of sugars commonly called glucose. These sugars differ in some of their properties from ordinary cane sugar, but cane sugar is easily changed into glucose:

$$\underset{\text{Cane Sugar.}}{\overset{IV\ I\ II}{C_{12}H_{22}O_{11}}} + \underset{\text{Water.}}{\overset{I\ II}{H_2O}} + \text{ferment} = 2\ \underset{\text{Glucose.}}{\overset{IV\ I\ II}{C_6H_{12}O_6}}$$

So, whether we start with starch or cane-sugar, glucose is produced by one kind of fermentation, and this glucose is then converted by yeast into alcohol and carbonic acid. In beer, the alcohol is the product desired, but in bread-making the chief object of the fermentation is to produce carbonic acid to puff up the bread, the alcohol escapes in the baking.

$$\underset{\text{Dextrose.}}{\overset{IV\ I\ II}{C_6H_{12}O_6}} = \begin{cases} 2\ \underset{\text{Alcohol.}}{\overset{IV\ I\ II}{C_2H_6O}} \\ 2\ \underset{\text{Carbonic Acid Gas.}}{\overset{IV\ II}{C\,O_2}} \end{cases}$$

The alcohol, if burned, would give carbonic acid gas and water.

$$\underset{\text{Alcohol.}}{\overset{IV\ I\ II}{2\,C_2H_6O}} + \underset{\text{Oxygen.}}{\overset{II}{12\,O}} = \underset{\text{Carbonic Acid Gas.}}{\overset{IV\ II}{4\,C\,O_2}} + \underset{\text{Water.}}{\overset{I\ II}{6\,H_2O}}$$

It will be seen that the total number of atoms

of carbon remains constant. There are six in the starch, and $2 + 4 = 6$ in the carbonic acid gas at the end, and but two atoms of hydrogen have been added, while 13 atoms of oxygen have been required; hence, 16 lbs. of starch will yield 26 lbs. of carbonic acid gas and 10.8 lbs. of water, more than double the weight of the starch. These products of decomposition are given back to the air in the same form in which those substances existed from which the starch was originally formed.

The same cycle of chemical changes goes on in the human body when starchy substances are taken as food. Such food, moistened and warmed in the mouth, becomes mixed with air, by reason of the property of the saliva to form froth, also it is impregnated with ptyalin, a substance which can change starch into sugar, as can the diastase of the malt. The mass then passes into the stomach, and the change once begun, goes on. As soon as the sugar is formed, it is absorbed into the circulatory system and is in some manner oxidized, changed into carbonic acid gas and water.

No starch is used in the human system as such; it must undergo this transformation into sugar before it can be absorbed. Whatever of it passes out of the stomach unchanged, meets a very active converter in the pancreatic juice. If grains of starch escape these two agents, they leave the system in the same form as that in which they entered it.

The cooking of pure starch as rice, farina, etc., requires little explanation. The starch grains are prepared by the plant to keep during a season of cold or drought, and are very close and compact; they need to be swollen and distended by moisture in order that the chemical change may take place readily, as it is a law that the finer the particles, the sooner a given change takes place. For instance, powdered alum will dissolve in water much sooner than a crystal of alum, or marble-dust in acid sooner than a piece of marble. Starch grains may increase in bulk twenty-five times in process of hydration.

The cooking of the potato and other starch-containing vegetables, is likewise a mechanical

process very necessary as a preparation for the chemical action of digestion; for raw starch has been shown to require a far longer time and more digestive power than cooked starch. Little change can take place in the mouth when the starch is not heated and swollen, and in case the pancreatic secretion is disturbed the starch may not become converted at all.

The most important of all the articles of diet which can be classed under the head of starch foods is bread. Wheat bread is not solely starch but it contains a larger percentage of starch than of anything else, and it must be discussed under this topic.

Bread of some kind has been used by mankind from the first dawn of civilization. During the earlier stages it consisted chiefly of powdered meal and water, baked in the sun, or on hot stones. This kind of bread had the same characteristics as the modern sea-biscuit, crackers and hoe-cake, as far as digestibility was concerned. It had great density, it was difficult to masticate, and the starch in it presented but little more

surface to the digestive fluids than that in the hard compact grain, the seed of the plant.

Experience must have taught the semi-civilized man that a light porous loaf was more digestible than a dense one. Probably some dough was accidentally left over, until fermentation had set in and the possibility of porous bread was thus suggested.

The ideal loaf, light, spongy, with a crispness and sweet pleasant taste, is not only æsthetically, but chemically, considered the best form in which starch can be presented to the digestive organs. The porous condition is desired in order that as large a surface as possible shall be presented to the action of the chemical converter, the ptyalin of the saliva. There is also a better aeration in the process of mastication.

Very early in the history of the human race, leavened bread seems to have been used. This was made by allowing flour and water to stand in a warm place until decomposition had well set in. A portion of this dough was used to start fermentation in fresh portions of flour and water

to be made into bread. This kind of bread had to be made with great care, lest lactic acid and other bodies, unpleasant to the taste, should be formed.

Because of this disagreeable taste, and because of the possibility that the dough might reach the stage of putrid fermentation, chemists and physicians sought for some other means of rendering the bread light and porous. The search began almost as soon as chemistry was worthy the name of science, and one of the early patents bears the date 1837. A good deal of time and thought has been devoted to the perfecting of unfermented bread; but since the process of beer making has been universally introduced, yeast has been readily obtained, and is an effectual means of giving to the bread a pleasant taste. Since the chemistry of the yeast fermentation has been better understood, a change of opinion has come about, and nearly all scientific and medical men now recommend fermented bread.

The chemical reactions concerned in bread raising

are identical with those in beer making. To the flour and warmed water is added yeast, a substance capable of causing the alcoholic fermentation. The yeast begins to act upon the starch at once, especially if the dough is of a semifluid consistency, but no change is evident to the eye for some hours, as the formation of sugar gives rise to no other products:

$$\underset{\text{Starch.}}{\overset{\text{IV I II}}{C_6H_{10}O_5}} + \underset{\text{Water.}}{\overset{\text{I II}}{H_2O}} = \underset{\text{Sugar.}}{\overset{\text{IV I II}}{C_6H_{12}O_6}}$$

But as soon as the sugar is decomposed into alcohol and carbonic acid gas, the latter product makes itself known by the bubbles which appear and the consequent swelling of the whole mass.

$$\underset{\text{Sugar.}}{\overset{\text{IV I II}}{C_6H_{12}O_6}} = \begin{cases} \underset{\text{Alcohol.}}{\overset{\text{IV I II}}{2C_2H_6O}} \\ \underset{\text{Carbonic Acid Gas.}}{\overset{\text{IV II}}{2CO_2}} \end{cases}$$

It is the carbonic acid gas (carbon dioxide) which causes the sponge-like condition of the loaf by reason of the peculiar tenacity of the gluten, one of the constituents of wheat. It is a well-known fact that no other kind of grain will make

as light bread as wheat. It is the right proportion of gluten (a nitrogenous substance to be considered later), which enables the light loaf to be made of wheat flour.

The production of carbonic acid gas is the end of the chemical process, the rest is purely mechanical. The kneading is for the purpose of rendering the dough elastic by a spreading out and thorough incorporation of the already fermented mass with the fresh flour.

Another reason for kneading is, that the bubbles of gas may be broken up into as small portions as possible, in order that there may be no large holes, but only very fine ones, evenly distributed through the loaf, when it is baked.

The temperature at which the dough should be maintained during the chemical process, is the most important point. A lesson can be learned from the distillers of spirit. The best temperature for the first stage of the alcoholic fermentation is 70° to 75° F., the maximum is 82° to 90°. Above 90°, the production of acetic acid is liable to occur.

STATE NORMAL SCHOOL,
Los Angeles, Cal.

$$\underset{\text{Alcohol.}}{\overset{IV\ I\ II}{C_2H_6O}} + \overset{II}{O_2} = \underset{\text{Acetic Acid.}}{\overset{IV\ I\ II}{C_2H_4O_2}} + \overset{I\ II}{H_2O}.$$

The more dense the dough, the more yeast is needed. After the dough is stiffened by the fresh flour and is nearly ready for the oven, the temperature may be raised to 160° or 165° F., the temperature of the beer mash. A quick change then occurs which is so soon stopped by the heat of the oven, that no time is allowed for souring.

In the use of leaven, the lactic fermentation is liable to take place, because sour dough often contains a ferment different from ordinary yeast, and this produces a different set of reactions.

The temperature should be carefully regulated, if light and sweet bread is desired. The baking of the loaf has for its object to kill the ferment, to heat the starch sufficiently to render it easily soluble, to expand the carbonic acid gas and drive off the alcohol, and to form a crust which shall have a pleasant flavor. The oven must be hot enough to raise the temperature of the inside of the loaf to 212° F. The most favorable temperature for baking is 400° to 550° F.

The brown coloration of the crust, which gives a peculiar flavor to the loaf, is probably caused by decomposition due to the high heat. Some dextrine may be formed. One hundred pounds of flour are said to make from 126 to 150 pounds of bread. This increase of weight is due to the incorporation of water, very possibly by a chemical union, as the water does not dry out of the loaf as it does out of a sponge.

The bread seems moist when first taken from the oven, and dry after standing some hours, but the weight will be found nearly the same. It is this probable chemical change which makes the difference, to delicate stomachs, between fresh bread and stale. A thick loaf is best eaten after it is twenty-four hours old, although it is said to be "done," when ten hours have passed. Thin biscuits do not show the same ill effects when eaten hot. The bread must be well baked in any case, in order that the process of fermentation may be stopped.

The expansion of water or ice into 1700 times its volume of steam is sometimes taken advantage of in making snow-bread, water gems, etc. It

plays a part in the lightening of pastry and of crackers.

Air, at 70°, expands to about three times its volume at the temperature of a hot oven, so that if air is entangled in a mass of dough, it gives a certain lightness when the whole is baked. This is the cause of the sponginess of cakes made with eggs. The viscous albumen catches the air and holds it, even when it is expanded, unless the oven is too hot, when the sudden expansion is liable to burst the bubbles and the cake falls.

As has been said, the production of the porous condition, by means of carbonic acid, generated in some other way than by the decomposition of starch, was the study of practical chemists for some years. Among the first methods proposed, was one undoubtedly the best theoretically, but very difficult to put in practice, viz., the liberation of carbonic acid gas from bi-carbonate of sodium, by means of muriatic acid.

$$\underset{\text{Soda.}}{\overset{\text{I}\quad\text{I}\;\text{IV}\;\text{II}}{\text{Na H C O}_3}} + \underset{\text{Hydrochloric Acid.}}{\overset{\text{I}\quad\text{I}}{\text{H Cl}}} =$$

$$= \overset{\text{I}\quad\text{I}}{\text{Na Cl}} + \overset{\text{I}\quad\text{II}}{\text{H}_2\text{O}} + \overset{\text{IV}}{\text{C O}_2}$$

The difficulty lies in the fact that this liberation of gas is instantaneous on the contact of the acid with the soda, and only a skilled hand can mix the bread and place it in the oven without the loss of much of the gas. Tartaric acid, the acid phosphates, sour milk (lactic acid), vinegar (acetic acid), alum, all of which have been used, are open to the same objection. Cream of tartar is the only acid substance commonly used which does not liberate the gas by simple contact in the cold. It unites with soda only when heated, because it is very slightly soluble in cold water. For the even distribution of the gas by thorough mixing, cream of tartar would seem to be the best. The chemical reaction is shown in the table on page 49 But as, beside gas, there are other products which remain behind in the bread, in the case of all the so-called baking powders, the healthfulness of these residues must be considered.

Common salt, the residue from the first-mentioned reaction, is the safest, and perhaps the residues from acid phosphate are next in order.

The tartrate, lactate, and acetate of sodium are not known to be especially hurtful. As the important constituent of Seidlitz powders is Rochelle salt, the same compound as that resulting from the use of cream of tartar and soda, it is not likely to be very deleterious, taken in the small quantities in which even habitual "soda-biscuit" eaters take it.

The various products formed by the chemical decomposition of alum and soda are possibly the most injurious, as the sulphates are supposed to be the least readily absorbed salts. Taking into consideration the advantage given by the insolubility of cream of tartar in cold water, and the comparatively little danger from its derivative, Rochelle salt, it would seem to be, on the whole, the best substance to add to the soda in order to liberate the gas; but the proportions must be chemically exact, according to the reaction given. At least, there must be no alkali left, for a reason which will be given under the head of hindrances to digestion.

Hence, baking powders prepared by weight

and carefully mixed, are a great improvement on the teaspoonful measured by guess. The reactions of the various baking powders with the proportions of each will be given on page 49.

Another group of substances which, by their slow combustion or oxidation in the animal body, yield carbonic acid gas and water, and furnish heat to the system, comprises the animal fats: as, for instance—suet, lard and butter; and the vegetable oils, as olive oil, the oily matter in corn, oats, etc.

These fatty materials all have a similar composition, containing when pure only carbon, hydrogen, and oxygen. They differ from starch and sugar in the proportion of oxygen to the carbon and hydrogen, there being very little oxygen relatively in the fatty group, hence more must be taken from the air for their combustion.

$C_{18} H_{36} O_2$	$C_6 H_{10} O_5$
Stearic Acid in Suet.	Starch.

One pound of starch requires one and two-tenths pounds of oxygen, while one pound of suet requires about three pounds of oxygen for perfect combustion. At the same time, a greater quantity of heat

can be obtained from the fats, pound for pound, than from starch or sugar; hence, people in Arctic regions require fat.

A most noticeable difference between the starch group and the fat group, is that the latter is stored up in the system against a time of need. This is the more easily done, since the fats do not seem to undergo any essential change in order that they may be absorbed. They pass the mouth and stomach without any chemical change, and only when they encounter the bile and the other intestinal juices, is there any question as to what happens.

With these fluids, the bile especially, the fats form emulsions in which the globules are finely divided and rendered capable of passing through the membranes into the circulatory system. The change, if any, is not one destructive of the properties of the fatty matters. The globules are carried along by the blood, and deposited wherever needed, to fill up the spaces in the muscular tissue, and to serve as a reserve supply of fuel.

There seems to be good reason for believing that the animal does derive some fat from the

other constituents of its food, but it is not an important question in the diet of mankind, for even the rice eaters use butter or oil with their food.

It must not be inferred from what has been said that the oxidation of starch and fat is the only source of heat in the animal body. A certain quantity is undoubtedly derived from the chemical changes of the other portions of food, but the chemistry of these changes is not yet fully understood.

CHAPTER III.

NITROGENOUS FOOD AND THE CHEMISTRY OF NUTRITION.

IN the previous chapter, the food necessary for the existence of the adult animal was considered; but animals do more than exist, they move and exert force, in mechanical terms they do work; also the young animal grows.

For growth and work, something else is needed beside starch and fat. The muscles are the instruments of motion and they must grow and be nourished, in order that they may have power. The nourishment is carried to them by the blood corpuscles. We find in these, as well as in muscular tissue, an element which we have not heretofore considered, nitrogen. We find it also in the products of their decomposition, hence we reason

that if the wear and tear of the muscles causes the liberation of nitrogenous compounds, which pass out of the system as such, this loss must be supplied by the use of some kind of food which contains nitrogen. Starch and fat do not; therefore they cannot furnish it to the blood.

The typical food of this class is albumen, white of egg; hence the terms albuminous and albuminoid are often used as descriptive of the group. The other common articles of diet containing nitrogen are the casein of milk, the musculine of animal flesh, the gluten of wheat, and the legumen of peas and beans. The proportion of the element in each is shown in the table on page 53.

The chemical changes which these bodies undergo are not well understood. The nitrogenous food is finely comminuted in the mouth, because, as before stated, chemical action is rapid in proportion to the fineness of division; but it is in the stomach that the first chemical change occurs.

The agents of this change are the pepsin and the acid of the gastric juice; the two together render the nitrogenous substance soluble and dia-

lysable, capable of passing through the membranes. Neither seems able to do this alone, and it does not seem to matter what acid is present so long as it is acid and just acid enough; but if the acid is neutralized, action ceases; hence the danger of soda biscuit with too much soda.

The chemical changes which go on after the albumen is taken into the system are not known. A decomposition of some sort takes place, and the nitrogen passes out of the system in *urea*, being separated by the kidneys, as carbonic acid gas is by the lungs.

The effect of cooking upon nitrogenous food should be such as will render the substance more soluble, because in this case digestibility means solubility. Therefore white of egg (albumen) and curd of milk (casein), when hardened by heat, must not be swallowed in lumps.

In the case of flesh, the cooking should soften and loosen the connecting tissue, so that the little bundles of fibre, which contain the nutriment, may fall apart easily when brought in contact with the teeth. Any process which toughens and hardens

the meat should be avoided. The cooking of beans and all leguminous vegetables should soften and loosen the compact grains. Hard water should be avoided, as an insoluble lime or magnesia compound of legumen is formed.

We have now considered the three classes of food under one or more of which all staple articles of diet may be placed—the starch food, the fats and the nitrogenous material. Some general principles of diet, indicated by science, remain to be discussed.

One of the most obvious questions is: Which is best,—starch or fat, beans and peas, or flesh? As to starch or fat, the question has been answered by experience, and science has only tried to explain the reason. The colder the climate the more fat the people eat. The tropical nations live chiefly on starch foods, as rice. From the statements on page 50, it will be seen that this is right; fat yields more heat than rice. Therefore the inference is plain that in the cold of winter fat is appropriate food, while in the heat of summer rice or some other starch food should be substituted.

No such evident rule can be seen in the case

of the albuminous foods. At most, the class can be divided into three groups. The first includes the material of vegetable origin, as peas, lentils, and the gluten of wheat. The second comprises the white of egg and the curd of milk, material of animal origin. The third takes in all the animal flesh used by mankind as food.

Considering the question from a purely chemical standpoint, without regarding the moral or social aspects of the case, two points stand out clearly: 1st. If the stored-up vegetable matter has required the force derived from the sun to prepare it, the tearing apart, and giving back to the air and earth, the elements of which it was built up, will yield so much force to whatever tears it down; but a certain amount of energy must be used up in this destruction. 2nd. If the animal, having accomplished this decomposition of the vegetable, and appropriated the material, is killed, and the prepared nitrogenous food in the form of muscle is eaten by man, then no force is necessary to render the food assimilable; it is only to be dissolved in order that it may enter into the circulation.

The force-producing power is not lost; it is only transferred to another animal body. Hence the ox or the sheep can do a part of man's work for him in preparing the vegetable food for use, and man may thus accomplish more than he otherwise could. There is, however, another side to this question. Nearly all, if not all, young animals live on food of animal origin. The young of the human race live on milk, but it has been found by experience that milk is not the best food for the adult to live upon to the exclusion of all else. It is not conducive to quickness of thought or general bodily activity.

This fact, with many others, leads us to the conclusion that mankind needs some vegetable food. Two other facts sustain this inference. The digestive organs of the herbivorous animals form fifteen to twenty per cent. of the whole weight of the body. Those of the carnivorous animals form five to six per cent., those of the human race about eight per cent. The length of the canal through which the food passes bears about the same relation in the three classes. A mixed

diet seems to be indicated as desirable by every test which has been applied, but the proportions in which the vegetable and animal food are to be mingled, as well as the relative quantities of carbonaceous and nitrogenous material which will give the best efficiency to the human machine are not so easily determined.

Dietaries, based upon experience and chemical analysis, have been prepared for soldiers' rations, and for use in prisons. Many cook-books and most works on physiology give lists of quantities.

One who has studied the question for years says: "Not only the age and occupation, but also the individuality of the person play an important part in the regulation of diet, and decide not only the quantity but also the kind of the food, and the form in which it is to be taken . . For the proper assimilation of the nourishment and its complete effect in the organism, the food must be agreeable; it must relish . . A supply of needful nourishment is not enough. Man requires yet more. He must find his food pleasing to the taste . . The boiling and roasting of food

materials are operations which we find only among civilized people, and they have been developed with the advance of civilization. The whole art of cooking amounts to this: So to prepare the food that it will best answer its end."*

The nutrition of the animal body, that is, the assimilation of the food taken, is dependent upon absorption. Absorption is dependent upon previous chemical processes. These processes are contingent upon the secretions, the saliva, the gastric juice, etc.; and it is a well-known fact that the flow of these liquids is, to a great extent, under the control of the nerves. Whatever excites the nerves pleasantly, causes an abundant secretion of the chemical agents of food change. In this fact lies the secret of modern cooking, the judicious use of condiments.

Pettenkofer (König, page 21) says of condiments: "I may compare them to the right use of lubricants for an engine, which indeed cannot replace the steam power, but may help it to a

* Die menschlichen Nahrungs-und Genussmittel, von Dr. J. König. Berlin, 1880. p. 100.

much easier and more regular action, and besides, prevent quite naturally the wearing out of the machine. In order to be able to do this, one condition is absolutely essential: the lubricant must not attack the machine, it must be harmless"

Cooking has thus become an art worthy the attention of intelligent and learned women. The laws of chemical action are founded upon the law of definite proportions, and whatever is added more than enough, is in the way. The head of every household should study the condition of her family, and tempt them with dainty dishes if that is what they need. If the ashes have accumulated in the grate, she will call a servant to shake them out so that the fire may burn. If she sees that the ashes of the food previously taken are clogging the vital energy of her child, she will send him out into the air, with oxygen and exercise to make him happy, but she will not give him more food.

Nature seems to have made provision for the excess of heat, resulting from the oxidation of too much starch or fat, by the ready means of

evaporation of water from the surface, this loss of water being supplied by drinking in a fresh supply, which goes, without change, into the circulation. The greater the heat, the greater the evaporation; hence the importance of water as an article of diet must not be overlooked. For an active person, the supply has been estimated at three quarts per day. Water is the heat regulator of the animal body.

While dangerous disease seldom seems to result from eating an excess of starch or fat, because the portion not wanted is rejected as so much sand, many of the most complicated disorders do result from an excess of nitrogen diet.

The readiness with which such substances undergo putrefaction, and the many noxious products to which such changes give rise, should lead us to be more careful as to the quantity of food.

A growing person needs about one part of nitrogenous food to four of starch and fat; a grown person, one part nitrogenous food to five or six of starch and fat. A fair average ration per day is perhaps:

Bread	1 lb. 10 oz.
Fat	1 to 2 oz.
Rice (cooked)	½ lb.
Flesh	½ lb.

All processes of cooking and the use of all condiments which hinder digestion should be avoided. Woody fibre or cellulose, as bran, irritates the digestive canal, and causes it to empty itself of the food before the chemical change is complete. An excess of sugar sometimes decomposes with the formation of acids which have the same effect.

Tannin, tobacco, salt in excess, and alcohol, all harden the albuminous part of the food, and by this means hinder solution.

Certain substances, as alcohol and coffee, lessen the amount of food needed for the time being.

The fats all decompose at about 300° F., into various bodies, some of them exceedingly acrid and irritating to the mucous membrane of the nose and throat, and which must also prove offensive to the lining of the stomach. This is probably the reason why many people cannot bear food fried in fat.

In counting the cost of the several articles of diet, not only the price per pound, but the digestibility must be taken into account.

It has been found by experiment that of the total starch in rice less than one per cent. is rejected, while in potatoes nearly eight per cent. is not used. (See table, page 52).

The cost of a diet which derives all the nitrogen from the animal kingdom has been estimated in Germany as 9.2 marks per day; while an entire vegetable diet, giving the same chemical construction, is given at 1.95 marks per day. This is a very evident reason why the working people of all lands (except America) live on vegetable food almost entirely.

$$\overset{\text{I I II}}{NaH(CO_3)} + \overset{\text{I I}}{HCl} = \overset{\text{I I}}{NaCl} + \overset{\text{I II}}{H_2(CO_3)} \left(\text{or } \overset{\text{I II}}{H_2O} + CO_2\right)$$

84 — Soda. | 36.5 — Muriatic Acid. | 58.5 — Salt. | Water. | 44 — Carbonic Acid Gas.

$$2\overset{\text{I I II}}{NaH(CO_3)} + \overset{\text{I II}}{H_2(C_4H_4O_6)} = \overset{\text{I II}}{Na_2(C_4H_4O_6)} + \overset{\text{I II}}{H_2O} + 2CO_2$$

2×84 — Soda. | 150 — Tartaric Acid. | (2×44) — Carbonic Acid Gas.

$$\overset{\text{I I II}}{NaH(CO_3)} + \overset{\text{I I II}}{KH(C_4H_4O_6)} = \overset{\text{I I II}}{KNa(C_4H_4O_6)} + \overset{\text{I II}}{H_2O} + CO_2$$

84 — Soda. | 188 — Cream of Tartar. | Rochelle Salt. | 44 — Carbonic Acid Gas.

$$6(\overset{\text{I I II}}{NaH(CO_3)}) + K_2Al_2\,4(SO_4) = K_2SO_4 + 3(Na_2SO_4) + Al_2O_3 + 3H_2O + 6CO_2$$

6×84 — Soda. | 517 — Alum. | 6×44 — Carbonic Acid Gas.

$$4(\overset{\text{I I II}}{NaH(CO_3)}) + 2\,(CaH_42(PO_4)) = Na_4H_22(PO_4) + Ca_2H_22(PO_4) + 4\,CO_2 + 4\,H_2O$$

4×84 — Soda. | 468 — Acid Phosphate. | 4×44 — Carbonic Acid Gas.

TABLE

Showing the Composition of some of the Materials used for food by Man.

OF ANIMAL ORIGIN.

NAME OF FOOD.	Water.	Nitrogenous Matter.	Fat.	Sugar.	Non-nitrogenous Matter, Starch, etc.	Woody Fibre.
	%	%	%	%		
Ox Flesh, very fat	54.76	16.93	27.23			
Ox Flesh, medium fat	72.25	21.39	5.19			
Mutton, medium fat	75.99	18.11	5.77			
Fish (Salmon)	74.36	15.01	6.42			
Fowl, fat	70.06	18.49	9.34			
Bacon, salted	9.15	9.72	75.75			
Ox Tongue, smoked	35.74	24.31	31.61			
Eggs	73.67	12.55	12.11			
Cow's Milk	87.41	3.41	3.66	4.82		
Butter (Market)	14.14	.86	83.11	.70		
Cheese, fat	35.75	27.16	30.43	2.53		
Cheese, not fat	48.02	32.65	8.41	6.80		

OF VEGETABLE ORIGIN.

NAME OF FOOD.	Water.	Nitrogenous Matter.	Fat.	Sugar.	Non-nitrogenous Matter, Starch, etc.	Woody Fibre.
	%	%	%	%		
Wheat (Mean of 250 Analyses) . .	13.56	12.42	1.70	1.44	66.45	2.66
Rye (Mean of 44 Analyses) . . .	15.26	11.43	1.71	.96	66.86	2.01
Barley (Mean of 112 Analyses) . .	13.78	11.16	2.12		65.51	4.80
Oats (Mean of 54 Analyses) . . .	12.92	11.73	6.04	2.22	53.21	10.83
Maize (Mean of 46 Analyses) . .	13.88	10.05	4.76	4.59	62.19	2.84
Rice (ready for Cooking)	14.41	6.94	.51		77.61	.08
Beans, Field (Mean of 29 Analyses)	14.84	23.66	1.63		49.25	7.47
Peas (Mean of 41 Analyses) . . .	14.31	22.63	1.72		53.24	5.45
Fine Wheat Bread	38.51	6.82	.77	2.37	40.97	.38
Potatoes (Mean of 70 Analyses) .	75.77	1.79	.16		20.56	.75
Sugar Beets	83.91	2.08	.11	9.31	2.41	1.14
Apples	83.58	.39		7.73	5.17	1.98
Grapes	78.18	.59		14.36	1.96	3.60

Digestibility of some articles of food shown by the per cent. of the several constituents rejected:

	Nitrogen.	Fat.	Starch Matter.
Maize	15.5	17.5	3.2
Rice	20.4	7.1	.9
Potatoes	32.2	3.7	7.6
Macaroni	17.1	5.7	1.2
Yellow Beets	39.0	6.4	18.2
White Bread	18.7		.8
Roast Meat	2.5	21.1	
Eggs	2.9	5.0	
Milk	7.0	7.1	
Butter	11.3	2.7	
Bacon	12.1	17.4	

It has been estimated (Moleschott) that a working man needs daily 130 grms.* of nitrogenous food and 448 grms. of non-nitrogenous food, starch, fat, etc.

The following table shows the weights of the different kinds of food which must be eaten in order that the required quantity may be obtained:

* 28 grms. = 1 ounce nearly.

	For 130 grms. Nitrogenous Substances.		For 448 grms. Non-nitrogenous Substances.
Cheese	338	Rice	572
Lentils	491	Maize	625
Peas	582	White Bread	631
Beans "Acker-bohnen"	590	Lentils	806
Ox Flesh	614	Peas	819
Eggs	968	Beans "Acker-bohnen"	823
White Bread	1,444	Eggs	902
Corn "	1,642	Rye Bread	930
Rice	2,562	Cheese	2,011
Rye Bread	2,875	Potatoes	2,039
Potatoes	10,000	Ox Flesh	2,261

Daily Rations in grms.

	Albuminous [(nitrogenous) Food.	Fat.	Starch Food.	Mineral Salts.	Water.
Soldier's Ration (ordinary)	119	56	485		
Soldier's Ration (very rich)	116	209	400		
Working Men	148	87	526	30	2858

(Mean of estimates by 12 different authorities.)

The daily need of a woman is counted as three-fourths or four-fifths that of a man.

ELEMENTARY COMPOSITION IN

	% of C.	H.	O.	N.	S.
Vegetable Albumen	53.1	7.2	20.5	17.6	1.6
Egg "	53.4	7.0	22.4	15.7	1.6
Flesh (Fowl)	53.18	7.03	.48	15.75	1.56
Casein (Curd of Milk)	53.5	7.05	.88	15.77	.8

Of 100 parts of food (solid and liquid) taken, is discharged:

By the Intestines	6.7	per cent.
" " Kidneys	49.3	" "
" " Skin and Lungs	42.6	" "

PART II.

—:o:—

CHAPTER I.

THE CHEMISTRY OF CLEANING.

NEXT to the materials for food, those used for the very necessary operations of cleaning are perhaps of greatest interest to the housekeeper.

This chapter will discuss the properties of the chemical substances which are suited to aid in performing the work of cleansing to the best advantage.

First in importance among these chemical materials are soap and its substitutes.

"Whether the extended use of soap be preceded or succeeded by an improvement in any community — whether it be the precursor or the result of a higher degree of refinement amongst the

nations of the earth — the remark of Liebig must be acknowledged to be true, that the quantity of soap consumed by a nation would be no inaccurate measure whereby to estimate its wealth and civilization. Of two countries with an equal amount of population, the wealthiest and most highly civilized will consume the greatest weight of soap. This consumption does not subserve sensual gratification, nor depend upon fashion, but upon the feeling of the beauty, comfort and welfare attendant upon cleanliness; and a regard to this feeling is coincident with wealth and civilization." *

It is surely a problem of the greatest interest to every housekeeper, how to keep her household and its belongings in a state of cleanliness that shall be a state of perfect health; for a large portion of disease is a direct result of uncleanly ways. [The toleration of impure air in close rooms is one of the most common, as well as one of the most easily remedied of these uncleanly ways.]

This state of cleanness must also be attained at the least cost in money, time and labor. Such

* Muspratt's Chemistry as applied to *Arts and Manufactures.*

STATE NORMAL SCHOOL,
Los Angeles, Cal.

a question ought to stir the business capacity of every woman in charge of a house. As we have said, soap and its substitutes justly claim, first of all, our attention.

Many primitive peoples find a substitute for soap in the roots, bark or fruit of certain plants. Nearly every country is known to produce such vegetable soaps, the quality which they possess of forming an emulsion with oily substances being due to a peculiar vegetable substance, known as Saponin. Many of these saponaceous barks and fruits are now used with good results — the "soap bark" of the druggist being one of the best substances for dressing over black dress goods, whether of silk or woollen.

The fruit of the Soapberry tree — *Papindus Saponaria* — a native of the West Indies, is said to be capable of cleansing as much linen as sixty times its weight of soap.

Wood ashes were probably used as cleansing material long before soap was made, as well as long after its general use. Their properties and value will be considered later.

Soaps for laundry use are chiefly composed of alkaline bases, combined with fatty acids. Their action is "gently but efficiently to dispose the greasy dirt of the clothes and oily exudations of the skin to miscibility with, and solubility in wash water." *

We may state it in this way. All kinds of cleansing, whether it be of our skins, our clothes, our painted wood-work, our windows or our dishes, consist of two distinct operations: first, the solution or emulsion of the oily matter which causes the dust and dirt to adhere; second, the mechanical removal of the dust and dirt, which, in most cases, is effected by water. Sometimes, as in the case of silver and paint, the cleansing agent is fine sand or chalk.

It will readily be seen that the first operation—the removal of the oily matter—is of prime importance in the laundry. In order clearly to understand the question of the best means to secure this removal, we must first consider the

* Chemistry applied to the Manufacture of Soaps and Candles. Morfit.

properties of the grease and oily matters, and next, what agents will dissolve them or form an emulsion with them.

Oily matters in general are soluble in certain substances, as salt is soluble in water, and can be recovered in their original form from such solutions by simple evaporation. Some of them readily combine with alkalies to form the kind of compound which we call soap. Others in contact with the alkalies form emulsions, so-called, in which the fatty globules are suspended, forming an opaque liquid. These emulsions are capable of being indefinitely diluted with clear water, and by this means the fatty globules are all carried away. The opacity of soap-suds is due to the fact that it contains particles in suspension, the nature of which will be presently shown.

Setting aside the vegetable saponin, we have then two classes of agents which affect oily matters,—the one class by simple solution, as turpentine, alcohol, ether, benzine, etc.; the other class by a direct union, or by the formation of an emulsion. Agents of the latter class are substances

known in chemistry as the alkali metals, and in order to justify the somewhat extended discussion of these alkali metals, we must remind our readers that the value of all soaps as detergents depends upon the alkali chiefly. To the distinguished French chemist, Chevreul, is due our knowledge of the action of soaps.

"The neutral salts formed by the alkalies and the fat acids are decomposed by the water, whereby insoluble double fat acid salts,—stearates, palmitates, oleates—are separated, while the alkali is set free. By means of the free alkali the impurities clinging to the materials are removed."

Every woman must have noticed the peculiar opaque appearance of soap-suds, even before anything has been washed in it. This is due to the suspension in the water of the particles of these "insoluble double fat acid salts."

[Hot water will dissolve soaps without this decomposition, but on cooling the separation takes place.]

As each soap-maker claims that his product contains something which renders it better than

other soaps, or different from them, and as the chief stress in his recommendation rests on the fatty matters used, "Oil soap is superior to resin soap," and the like, it behooves the housekeeper to remember that, within certain limits of course, the kind of fatty acid does not so much matter to her (provided only that it is not putrid or otherwise unfit for use) as the quantity and quality of the alkali, and as she is often called upon to believe that some new chemical has just been discovered which makes a far more efficient soap than the world has ever before seen, it may be instructive for her to follow our discussions of the alkali metals and their compounds.

The chemical group of "alkali metals" comprises six substances—Ammonium, Cæsium, Lithium, Potassium, Rubidium and Sodium. Two of the six— Cæsium and Rubidium — were discovered by means of the spectroscope, not many years ago, in the mineral waters of Dürckheim, and probably the total amount for sale of all the salts of these metals, could be carried in one's pocket. A third alkali metal — Lithium — occurs in several minerals,

and its salts are of frequent use in the laboratory, but it is not sufficiently abundant to be of commercial importance.

As regards the three remaining alkali metals, the hydrate of Ammonium, $(\overset{1}{N}H_4)\overset{1}{H}\overset{II}{O}$, is known as "Volatile Alkali," the hydrates of Potassium, $\overset{1}{K}\overset{1}{H}\overset{II}{O}$, and Sodium, $\overset{1}{Na}\overset{1}{H}\overset{II}{O}$, as "Caustic Alkalies." With these three alkalies and their compounds, and these alone, are we concerned in housekeeping. The volatile alkali, Ammonia, has been recently prepared in quantity and price such that every housekeeper may become acquainted with its use. It does not often occur in soaps, and its use is confined to the more delicate cleansing operations, the bath, the washing of woollens, and other cases where its property of evaporating, without leaving any residue to attack the fabric or to attract anything from the air, is invaluable. This property affords a safeguard against the carelessness of the laundress in not sufficiently rinsing the fabric, and this imperfect rinsing is at the bottom of most of the trouble in washing woollens with soap or caustic alkali. All flannels worn next the

skin, all the woollens of an infant's wardrobe, should be washed in water made soft and alkaline by ammonia, or ammonium carbonate. An additional advantage will be found in the fact that the shrinkage of woollens thus washed is very slight. The ammonium compounds are somewhat more expensive than the caustic alkalies, but in the present time, when an ammoniacal liquor is largely produced as a secondary product in the manufacture of coal gas, the cost is not excessive compared with the benefit its use confers. For use in the bath, and for woollens, the ammoniacal gas liquor must have passed through a process of purification, in order to free it from some other products of the destructive distillation of coal, which is not healthful or useful. This caution must be borne in mind, as a crude article is sometimes sold for cleaning paint or carpets; this is not fit for the uses we have been specifying.

Ammonia water, bought of the best dealers in chemicals and druggists' supplies, costs about 30 cents a pint, without the bottle.

A pint of this liquid possesses as much alkaline

value as ten ounces of sal soda, $\overset{I\ IV\ II}{Na_2CO_3} + 10\ \overset{I\ II}{H_2O}$, and has not the injurious properties of the latter, even when used in excess. As the alkali is volatile, and water nearly boiling will retain only about one seventh as much of the ammonia gas as water at the ordinary temperature of the air, it will be seen that the directions on the various bottles of "Magical" washing fluids which contain ammonia, to pour the required quantity into hot water, with the word "hot" especially emphasized, are at variance with the known properties of this substance. The fluid should be largely diluted with cold water, and then added to the warm water. never to water too hot to bear the hand in.

Ammonia is most excellent for cleaning glass (but not for brass, as it dissolves copper, and copper salts).

A teaspoonful of ammonia, added to a quart of water, is the best possible agent for cleansing hair brushes.

For use in travelling, the solid ammonium carbonate is preferable; for use in hard water it is

also better, as the lime is precipitated out by it as by sal soda. It costs twenty-five or thirty cents a pound, and one pound of it is of as much alkaline value as two pounds of sal soda.

Some compounds of the two alkali metals, Potassium and Sodium, are capable of saponifying fats and forming the complex substances known as soaps.

For these compounds of these alkalies, employed in the manufacture of soap, we shall use the popular terms "potash" and "soda," as less likely to cause confusion in our readers' minds. Potash makes soft soap; soda makes hard soap. Potash is derived from wood ashes, and in the days of our grandmothers soft soap was the universal detergent. Potash (often called Pearlash) was cheap and abundant. The wood fires of every household furnished a waste product ready for its extraction. Soda ash was, at that time, obtained from the ashes of sea-weed, and of course was not common inland. Aerated Pearlash (Potassium bicarbonate), under the name of saleratus, was used for bread.

The discovery by the French manufacturer, Leblanc, of a process of making soda ash from the cheap and abundant sodium chloride, or common salt, has quite reversed the conditions of the use of the two alkalies. Potash is now some eight cents a pound, soda ash is only three.

In 1824, Mr. James Muspratt, of Liverpool, first carried out the Leblanc process on a large scale, and he is said to have been compelled to give away soda by the ton to the soap-boilers, before he could convince them that it was better than the ashes of kelp, which they were using on a small scale. But the soap trade, as we now know it, came into existence after the soap-makers realized the value of the new process. Soda ash is now the cheapest form of alkali, and housekeepers will do well to remember this fact when they are tempted to buy some new "——ine," or "crystal."

In regard to the best form in which to use the alkali for washing purposes, experience is the best guide,—that is, experience reinforced by judgment; for the number of soaps, and soap substitutes, in the market is so great, and the names so little

indicative of their value, that only some general information can be given.

In the purchase of soap, it is safest to choose the make of some well-known and long-established firm, of which there are several who have a reputation to lose if their product is not good; and, for an additional agent, stronger than soap, it is better to buy sal soda (sodium carbonate) and use it knowingly, than to trust to the highly lauded packages of the grocery. A pound of sal soda contains from four to five times as much alkali as a pound of hard soap, and therefore it should be used with care.

Washing soda should never be used in the solid form, but should be dissolved in a separate vessel, and the solution used with judgment. The injudicious use of the solid is probably the cause of the disfavor with which it is so often regarded. One of the most highly recommended of the scores of "washing compounds" in the market, doubtless owes its popularity to the following directions: "Put the contents of the box into one quart of boiling water, stir well, then add three quarts of

cold water: this will make one gallon. For washing clothes, allow two cupfuls of liquid to a large tub of water."

As the package contains about a pound of *washing soda*, this rule, which good housekeepers have found so safe, means about two ounces to a large tubful of water, and this in solution.

Ten pounds of washing soda can be purchased of the grocer for the price of this one-pound package, with its high-sounding name. Nearly all the compounds in the market depend upon washing soda for their efficiency. Usually they contain nothing else. Sometimes soap is present and, rarely, borax. In one or two, ammonia has been found.

For hard water, a little sal soda is almost indispensable. Borax is a very good cleansing agent for many purposes. The sodium is in a milder form than in washing soda. For delicate fabrics and for many colored articles, it is the safest substance to use.

On first thought, we may wonder why we need to add these chemical agents to soap, when our

grandmothers did without them; but we must remember that our grandmothers used soft soap and wood ashes for all the cleansing operations for which we now depend upon hard soap. It is a recognized fact that soft soap is much more caustic and hence more effective in removing grease than hard soap. The reason for this lies partly in the fact that the gelatinous character of the soap allows a considerable proportion of free lye to be mechanically held in the mass, and partly because potash is a more powerful chemical agent than soda.

Many prudent housewives still make soft soap for their own use. Many more add to the efficiency of the common soap by dissolving several pounds of it in hot water, adding about one-third as many pounds of sal soda, and allowing the mass to cool into a white, soft curd.

A washing fluid, said to be of great value, is prepared by the addition of freshly slaked lime to a solution of sal soda. When the liquid has become clear, alcohol is added to it, and it is bottled for use.

Slaked lime, $\overset{II}{Ca}\overset{I}{H_2}\overset{II}{O_2}$, or caustic lime, and carbonate of soda, $\overset{I}{Na_2}(\overset{II}{CO_3})$, put together in solution, must inevitably result in carbonate of lime, $\overset{II}{Ca}(\overset{II}{CO_3})$, and caustic soda, $\overset{I}{2}\overset{I}{Na}\overset{II}{HO}$, — a compound much more dangerous to use in excess than sal soda. The alcohol dilutes this caustic solution, and the little gill cup used to measure the fluid for use, insures safety. The mistress who considers herself cautious will sanction the use of this "fluid," when she will not allow sal soda to be used.

Turpentine has been sometimes recommended as an addition to washing fluids, but its use may be attended with danger, as, when applied in hot water, to the bare arms of the laundress, it is readily absorbed, and is liable to cause illness.

There is a compound of sodium of great value for laundry and common use, which seems to take the place of the old-time soft soap. This is sodium silicate, water-glass, or soluble glass. It is manufactured for print works, and its common name is "water-glass," that is, glass soluble in water, and free from the lime or lead of the common window-

glass. Being made from clean materials, sand and soda, or potash, it has no reminder of the dead meat or bone-boiler's establishment, as soap sometimes has. The affinity of the alkali for the silica is not strong, and yet it holds until some stronger acid comes in contact with it. By virtue of this property, it is said by the few housekeepers who have hitherto had access to it, not to injure the fabric, even if used in excess, and to give to linen the clean, fresh appearance of new cloth. It is hoped that an agent so valuable to the housekeeper may soon be accessible to all.

The removal of spots from clothing is a subject which has perplexed every woman.

The fabrics upon which we wish to operate are nearly all colored, and the modern dye is such a complex and unstable compound that disaster is not uncommon.

Chloroform, ether, alconol, benzine, turpentine, all dissolve grease, but all are liable to show an enlarged ring if not very carefully applied, and the water in ether and alcohol affects many colors. Turpentine is useful for some coarser fabrics, but

for the most delicate silks and woollens benzine or naphtha is the safest, not injuring the color, and, if pure, completely volatile.

For grease on carpets or other articles, where washing is out of the question, absorbents may be used: such as powdered soapstone, magnesia, buckwheat flour, etc.

These absorbents are also sometimes used to remove spots other than those caused by grease.

Grass stains often baffle the best laundress. A sure, if expensive, solvent for chlorophyl (the green coloring matter of plants) is alcohol, if applied while the stain is still fresh. Fruit stains are generally removed by the well-known process of pouring on boiling water. In some cases oxalic acid is better.

Red iron rust is most readily soluble in muriatic acid, and if one has a little knowledge of chemical principles, this acid may be of great use in the laundry. It is very readily washed out with clear water, and it does not affect most fast colors. As the iron compound formed is also soluble, it can be taken away entirely. The efficacy of salt with

lemon is probably due to the setting free of a small amount of muriatic acid.

Black iron stains, as those from the inks made with iron, may be best removed by oxalic acid, although it has little effect on red iron stains. The iron forms a colorless compound with the acid but great care must be taken to remove all of it by a thorough washing. The difficult solubility of oxalic compounds makes this harder. It is well to wash the article with ammonia water finally, in order to remove the last traces of acid. Oxalic acid and ammonia are two of the most useful agents in the laundry. For further details, see chapter II.

It may comfort some young housewife to know that mildew is beyond the art of the chemist. It seems to be a vegetable growth, which attacks the cotton fibre, and in a measure destroys it, as dry rot does a stick of timber. If it is superficial only, successive washings and bleachings in the sun will remove it. If deep seated, its removal is hopeless; as in other cases, prevention is the best cure. Some cloth is very liable to mildew, and

servants are often blamed for its appearance without good cause.

We will now consider some of the preparations for the mechanical removal of "matter in the wrong place"—tarnish on silver, spots on paint, etc.

The matron of fifty years since, took care of her silver herself, or superintended the cleaning very closely, for the heirlooms were precious, or the gifts of friends valuable. The silver was hardened by a certain proportion of copper, and took a polish of great brilliancy and permanence. The matron of to-day, who has the same kind of silver, and who takes the same care, is the exception. Plated ware is found in nearly every household in our villages. The silver deposited from the battery is only a thin coating, and is of pure, soft metal—very bright when new, but easily scratched, easily tarnished, and never again capable of taking a beautiful polish. The utensils, being of comparatively little value, are left to the table-girl to clean, and of course she uses the material which will save her labor.

In order to ascertain if there was any foundation for the prevalent opinion that there was mercury

or some equally dangerous chemical in the silver powders commonly sold, we have purchased samples in Boston and vicinity, and in New York and vicinity.

Thirty-eight different kinds have been found. Of these,

25 were dry powder.
10 " partly liquid.
3 " soaps.

Of the twenty-five powders, fifteen were chalk or precipitated calcium carbonate, with a little coloring matter, usually rouge.

6 were diatomaceous earth.
2 " fine sand entirely.
2 " " " partly.

Mercury was found in none. No other injurious chemical was found in any save the "electro-plating battery in a bottle," which contained potassium cyanide, KCN, a deadly poison; but it was labelled poison, although the label also stated that all salts of silver are poison when taken internally. This preparation does contain silver, and does deposit a thin coating, but it is not a safe article.

Of the nine polishes, partly liquid, five contained alcohol and ammonia for the liquid portion; four, alcohol and sassafras extract. The solid portion, in all cases, was chalk, with, in one case, the addition of a little jeweller's rouge.

The caution to be observed in the use of these preparations is in regard to the fineness of the material. A few coarse grains will scratch the coating of soft silver. Precipitated chalk, $\overset{II}{Ca}\overset{IV}{C}\overset{II}{O_3}$, or well-washed diatomaceous earth, $\overset{IV}{Si}\overset{II}{O_2}$, seem to be of the most uniform fineness.

We may learn a lesson in this, as well as in many other things, from the old-fashioned housewife. She bought a pound of whiting for twelve cents, floated off the fine portion, or sifted it through fine cloth, and obtained twelve ounces of the same material, for three ounces of which the modern matron pays twenty-five or fifty cents, according to the name on the box.

Silver is liable to tarnish from many causes, some of which can be avoided. Flannel is apt to contain sulphur, and should not be used to wrap up

silver articles. Clean, soft tissue paper first, then a bag of Canton flannel, form a good covering. Want of sufficient ventilation in a house shows itself very quickly by the tarnish on the silver, caused by foul air and coal gas.

Iron and steel oxidize in damp air, according to the rule that the presence of water favors chemical change. A little oily coating will exclude the air and hence no oxidation can ensue.

The mechanical removal of spots on paint and kitchen utensils is effected by scouring agents, such as chalk, $\overset{II}{Ca}\overset{IV}{C}\overset{II}{O_3}$, whiting, impure $\overset{II}{Ca}\overset{IV}{C}\overset{II}{O_3}$, pumice and Bristol brick (silicates), fine sand $\overset{IV}{Si}\overset{II}{O_2}$, and preparations which owe their cleansing properties to one of these solids.

A frequent source of annoyance is the bluing, which seems to be indispensable to the city laundress, who has not fresh grass, or the white snow of the country on which to whiten her clothes.

Three substances are at present used for this purpose. Indigo, from the plant *Indigo tinctoria*, has been known from time immemorial. Soluble

Prussian blue, a chemical compound containing iron, is a recent invention. Ultramarine, the third, is a silicate, insoluble in water, giving a tint by means of the very fine blue powder, which is impacted in the cloth.

The indigo bags of olden time have been almost entirely replaced by numerous "Soluble Blues," all of which are Prussian blue of greater or less strength.

It must be borne in mind that this substance is decomposed by the fixed alkalies, and if the clothes are not rinsed free from soap-suds or washing soda, mysterious iron-rust spots may appear on the linen, caused by the decomposition of the bluing. The general yellowish tint, which is so often seen on linen, is probably due to this cause.

Of fifteen different kinds of bluing which were examined, not one was anything but Prussian blue. Here, as in so many other cases, the young housekeeper who has had some training in a chemical laboratory, has an advantage over one who has not, in her idea of absolute cleanliness, and her conception of the inexorable laws of chemical change.

A long chapter might be written on the subject of economy in the case of the multitude of chemical preparations so freely offered for sale. There is so much for the young housewife to do that she is tempted by every promise of making labor easier, and is very ready to try anything that is recommended.

She thinks that if her servants are provided with all the modern appliances for doing work quickly and well, it is their fault if they do not accomplish it. She forgets that the past generation of women, who succeeded in keeping their families healthy and happy, brought brains to the work; they knew, too, the properties of the substances they used, because they prepared them at home.

When American girls will learn to apply Chemistry and Physics to every-day life, we may hope for a speedy solution of the servant-girl question.

CHAPTER II.

CHEMICALS FOR HOUSEHOLD USE.

1. *Acids.*

THERE are three acids which should be found in every laundry cupboard: acetic acid, $C_2H_4O_2$; muriatic or hydrochloric acid, HCl; and oxalic acid, $C_2H_2O_4$.

Vinegar can be used in many cases instead of acetic acid; but vinegar contains coloring matters which stain delicate fabrics, and it is better to use the purified acid, especially as the so-called vinegar may contain sulphuric acid.

If soda has been spilled on black silk an application of acetic acid will usually restore the color.

Many of the bright blue flannels and other fabrics found at the present time in our markets owe their brilliánt shades to an acid compound of a coal-tar color, and as soon as they are washed in soap or ammonia, the alkali neutralizes the acid, and the color becomes pale and faded in appearance. If acetic acid or vinegar is added to the second rinsing water, the bright color is in all such cases restored. This fact was discovered by accident, and is well worth remembering. Of course, not all shades of blue are made with this compound, and hence not all faded blues can be thus restored. It is well to test a bit of the cloth before washing the whole garment.

A weak acid like acetic acid is safe to use on many fabrics which would be injured by a strong acid.

Muriatic or hydrochloric acid is useful in a multitude of ways. By means of it, the writer once restored, in a few minutes, a delicate blue cambric dress, which had been quite ruined by numerous large stains of red iron rust. The cloth was laid over a large bowl half filled with hot water,

and the spots thus steamed were touched with a drop of the acid, and as soon as the iron was dissolved, the cloth was plunged into the water to prevent injury to the cotton fibres. All the spots were thus dissolved off; the garment was then quickly rinsed in several waters, and finally in water containing a little ammonia, which neutralized any trace of acid still remaining. This process is by far the best for removing red iron stains from white cloth.

Porcelain or china, stained with iron, can be cleaned with muriatic acid. For the porcelain or enamelled water-closet basin it is especially useful, but the acid must be removed by rinsing with water followed by a little alkali to save the iron pipes below.

The acid must not be used on marble, as it dissolves it with great rapidity, and the polish is lost.

The property which muriatic acid, in common with the so-called stronger acids, possesses—that of liberating carbonic acid gas with brisk effervescence from its compounds, renders this acid valuable for the detection of carbonates.

For instance, if the label of a washing powder claims it to be something new, and requires that it be used without soda, as soda injures the clothes, it can be tested as follows: Put half a teaspoonful of the powder into a tumbler, add a little water, then a few drops of muriatic acid. A brisk effervescence will prove it to be a carbonate, and if the edge of the tumbler is held near the colorless flame of an alcohol lamp, the characteristic yellow color of sodium will complete the proof. If the acid is added drop by drop until no more effervescence occurs, and there remains a greasy scum on the surface of the liquid in the tumbler, the compound contains soap as well as sal soda, for the acid unites with the alkali of the soap and sets free the grease.

If some very costly silver polishing powder is offered as superior to all other powders, a drop or two of muriatic acid will decide whether or not it is chalk or whiting ($\overset{II}{Ca}\overset{IV}{C}\overset{II}{O_3}$) by the effervescence or liberation of the carbonic acid gas.

Oxalic acid is purchased in white crystals, and for use a saturated solution is made; as one

part of it dissolves only in several parts of water, it is well to keep an excess of the crystals in the bottle. It is somewhat poisonous, and should not be left in the solid form within reach of careless people. A small bottle of liquid can, however, be kept with other laundry articles.

This acid is the only efficient means which is known to the writer, for removing the shoe-leather stains from white stockings. It will take out most fruit stains on napkins and from the fingers; for the latter purpose tartaric acid will also serve.

Oxalic acid is invaluable to the housekeeper as a means of removing black iron stains, such as those caused by the iron inks.

It is a more powerful acid than acetic acid, and must be carefully removed from cloth by rinsing with water and finally by ammonia.

Oxalic acid is very efficient as an agent for cleaning brass, and seems even safer to use than acetic, as the compound of the latter with copper salts is one of the most dangerous of the copper compounds.

IVII

Sulphurous acid gas (SO_2) is obtained by burning sulphur, and is the well-known agent for bleaching. It will often remove spots which nothing else will touch. The cloth or other substance should be moistened and held over a bit of burning sulphur; as the agent is an acid, the same precautions must be observed as in the case of the other acids, as to the removal of the corrosive substance.

2. *Alkalies.*

The uses of ammonia water and ammonium carbonate, have been considered in the text; a precaution to be taken is, that the bottles should not be kept with other bottles containing liquids for internal use, as distressing accidents have occurred from swallowing ammonia.

Caustic soda or potash is better for greasy tins than soap; a swab should be used to apply it, however, as it is corrosive to the hands. Silicate of soda may also be used for this purpose.

Some alkali should be always at hand. The alkali compounds, sodium carbonate (sal soda)

$\overset{I\ IV\ II}{Na_2CO_3} + H\ \overset{I\ II}{IO}\ \overset{I\ II}{H_2O}$ and calcium carbonate $\overset{II\ IV\ II}{CaCO_3}$, are of daily use as has been already explained in the previous chapter.

BOOKS FOR REFERENCE.

—:o:—

FOR TEACHERS:

"History of Chemical Theory."

A. Wurtz.

Translated and edited by Henry Watts.

"Elementary Manual of Chemistry."

Eliot and Storer.

"Physiology and Hygiene." (Chapter on Digestion.)

Huxley and Youmans.

"Treatise on Chemistry."

Roscoe and Schorlemmer.

FOR GENERAL READERS:

"Elements of Chemistry."

Le Roy C. Cooley.

"The Birth of Chemistry."
Rodwell.

"Chemistry of Common Life."
Johnston and Church (new edition).

"The New Chemistry."
J. P. Cooke.

"Lessons on Elementary Chemistry."
Henry E. Roscoe.

"Fermentation."
Schützenberger.

"Vorträge uber die Entwickelungsgeschichte der Chemie in den letzten Hundert Jahren."
Dr. A. Ladenburg.

Table of some common elements with their atomic weights and symbols.

NAME.	SYMBOL.	ATOMIC WEIGHT.
Hydrogen	I H	1.
Chlorine	I Cl	35·5
Sodium	I Na	23.
Potassium	I K	39.1
Silver	I Ag	108.
Oxygen	II O	16.
Copper	II Cu	63.4

NAME.	SYMBOL.	ATOMIC WEIGHT.
Calcium	II Ca	40.
Barium	II Ba	137.
Lead	II Pb	207.
Zinc	II Zn	65.2
Boron	III B	11.
Gold	III Au	197.
Iron	II Fe or IV Fe	56.
Aluminum	II Al or IV Al	27.4
Tin	II Sn or IV Sn	118.
Silicon	IV Si	28.
Carbon	IV C	12.
Nitrogen	III N or V N	14.
Arsenic	III As or V As	75.

INDEX.

PAGE.

Absorption of Food, . . . 44
Acetic Acid, ... 80
Acids:
  Acetic, ... 80
  Hydro-chloric or Muriatic, 80
  Oxalic, ... 73-80
  Tartaric, ... 49
Acid Phosphate, ... 49
Albumen, ... 38
Albuminous Food, ... 41
Alcohol, ... 21-59-71
Alkalies, ... 85
  Caustic, ... 62
  Volatile, ... 62
Alum, ... 33-49
Ammonia, ... 61-63-64-85
Ammonium Carbonate, . 63-64-85
Assimilation, ... 44
Atomic Weight, ... 5
Baking Powders, ... 32 49
Benzire, ... 57-71
Bluing, ... 77
Books for Reference, . . . 83
Borax, ... 68
Bread, ... 24
  Fermented, ... 28
  Reason for Kneading. . 24
  Temperature for Fermenting 28
  Temperature for Baking, 29
  Snow Bread, ... 30
  Soda-Bread, ... 31-32-33
Carbonic Acid Gas, . . . 27-31-49
Cæsium, ... 61
Chemical Change, ... 1-16
  Element, ... 3
  Equation, ... 11
  Reaction, ... 11
Chloroform, ... 71

PAGE.

Cleaning:
  Brass, ... 84
  Brushes, ... 64
  Glass, ... 64
  Paint, ... 64
  Silver, ... 74-75
Cooking, ... 45
  Of Starch, ... 23
  Of Nitrogenous Food, . 39
Cost of Nitrogenous and Vegetable Diet in Germany compared. 18
Cream of Tartar, ... 32-49
Danger:
  Acetic Acid on Copper, . 84
  Ammonia, ... 85
  "Battery in a Bottle," . 73
  Hard water, ... 40
  Soda, ... 30
  Turpentine in Washing, . 70
Diastase, ... 20
Ether, ... 59-71
Fats, ... 34-35
  Decomposition of . . . 47
  Fruit Stains, ... 72
Glucose, ... 21
Gluten, ... 27
Grass Stains, ... 72
Grease on Carpets, ... 72
Growth Nitrogenous Food required for, ... 37
Heat—Artificial, ... 16
  Source of in Animals, . 17
Heat-producing Food, . . . 18
Ink Stains, ... 73
Iron, Black Stains of . . 73-82-84
  Rust, ... 72-78-81
Law of Definite Proportion by Weight, ... 12

PAGE.

Lime, ... 70
Lithium, ... 61
Magical Washing Fluids, . . 64
Mildew, ... 73
Milk. 42
Muriatic Acid 81
Nitrogen, ... 37
Percentage of in Food, . 50-53
Required in Growth and Work, ... 37
Oils, ... 34-35
Oxalic Acid, ... 83
Pearl Ash, ... 65
Plate Powders, ... 75
Potash, ... 65-85
Potassium, ... 61
Potassium Cyanide, ... 75
Principles of Diet, ... 40
Properties of Substances, . . 1
Proportion of Nitrogenous Food required, . . . 46
Ptyalin in Saliva, ... 22
Relation of Climate to Food, 40
Removal of Spots, . . . 71-72-85
Residues from Baking Powders, ... 32-33
Restoring Color, ... 80-81
Rochelle Salts, ... 49
Rubidium, ... 61
Rust of Iron, ... 72-81
Sal Soda, ... 65-67-85
Salt, ... 32-47
Saponin. 57
Silver-Tarnish, ... 74
Snow-Bread 30
Soap, ... 55-58
Bark, ... 57
Berry Tree, ... 57
Soda, ... 33-49-85
Soda Ash, ... 66
Soda Bread, ... 31-32-33
Sodium, ... 61
Carbonate, ... 67
Silicate, ... 70
Soft Soap, ... 69

PAGE.

Soluble Glass. 70
Stains, ... 71-72-80-82-84
Starch, ... 18
Chemical Changes of . . 20
Cooking of 23
Sugar. 20
TABLES:
I. Atomic Weights, . 5
II. Exchangeable Values, ... 7
III. Interchangeable Values, . . . 9
IV. Mineral Acids, . . 14
Baking Powders . . . 49
Composition of Some Animal Food, ... 50-54
Composition of Some Vegetable Food, . . 51-54
Comparative Digestibility of Food, ... 52
Daily Weight of Food Required, ... 53
Percentages of Waste, . 54
Tannin, ... 47
Temperature for Fermenting Bread, ... 28
For Baking Bread, . . 29
Tests with Muriatic Acid, . 83
Tobacco, ... 47
Turpentine, ... 59-70-71
Transfer of Force-Producing Power, ... 42
Unit of Value, ... 6-7
Vinegar, ... 80
Volatile Alkali, ... 62
Yeast, ... 27
Yellow Tint on Linen, . . . 78
Washing Fluids, ... 69-70
Washing Woollens, ... 62-63
Water as the Heat-Regulator of the Body, ... 46
Water Glass, ... 70
Wood Ashes, ... 57-59
Work, Nitrogenous Food Required for 37

This book is DUE on the last date stamped below

University of California
SOUTHERN REGIONAL LIBRARY FACILITY
Return this material to the library
from which it was borrowed.

REC'D LD-URL
OCT 01 1990
MAY 30 19[illegible]

UC SOUTHERN REGIONAL LIBRARY FACILITY
A 000 503 901 1

UNIVERSITY of CALIFORNIA
AT
LOS ANGELES
LIBRARY